

Pothole Repair and Compaction Technology of Asphalt Pavement

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Abstract: For the gradual emergence of asphalt pavement pit phenomenon, analyze the situation of pits phenomenon and reasons, and proposed direct packing method, dig method, hot baked repair method, jet method in pothole repair technology, proposed vibration and oscillation compaction technology in compaction technology, select and use depending on the circumstances.

Keywords: Asphalt concrete; Pit; Repair; Compaction

1. Introduction

Under the action of natural forces or poor construction quality, too small asphalt binder, exotic rainfall as well as the impact of heavy-duty vehicles, and the mixture become loose as its adhesion between the mixture is not enough, at the same time, and they didn't close the traffic in time, the soon pits phenomenon. The main task of pothole repair is to repair and improve the cracks and parts of networks crack. And to deal with the phenomenon of local subsidence, fracture displacement, and hug bag[1].

2. Current Situation of Repairing Asphalt Pavement Pit

Analyze no matter from any angle, pit is one of those threat to the safety and stability of asphalt concrete pavement[2], and has three major characteristics(instant, frequent, contagious), is the focus and difficulty of pavement maintenance. Pothole problem is particularly prominent especially in the rainy day or in festival. This reflects the flood and overweight are the two main reasons resulting in the phenomenon of pit on the other hand. With the change of time, at home and abroad, the maintenance technology of asphalt pavement pits and cracks have made a difference[3]. But strictly speaking, the pavement crack filling and pit maintenance in the fine degree still has certain limitations, especially in the country. At present, the type of pavement repair material is so many, but it does not appear one or more of the materials in the performance far superior to other types of materials, in terms of material selection, it must be based on each situation to make specific choices in line with its characteristics. According to those examples, the conclusion has appeared, only by combining the materials, construction technology, pressure equipment together can we make the final pit road maintenance work to achieve optimal efficiency, and make the final curing effect last for a longer time.

3. Pit Repair Technology

Currently repair technique is divided into four categories according to the different maintenance mode and pit maintenance equipment, they are direct packing method, pothole patching type repair method, heat drying type repair method and jet method.

3.1. Direct packing method

Direct packing method can not be used as an emergency repair method for a long time, Specific approach is to clean pit internal impurities and excess mixture firstly, and then directly fill in the required asphalt mixture, forming the final rolling. The advantage of this method is that it can be used to achieve the results of the repair in a short period of time. It is suitable for conservation under unfavorable rainy winter season and harsh environments, however, the downside is that conservation is too rough, it may be need another repair after used for some time, may also increase a lot of work in general

3.2. Pothole Patching type repair method

Pothole Patching type repair method become more and more common in highway maintenance, the specific approach is to cut irregular road into a regular rectangle. In order to deal with road damage completely, it need to be dug to the bottom of the intact part at the time of excavation, this is to firmly support the surface layer, then the final life of pavement system is greatly improved[4]. US Highway Strategic Plan also summed up by special test, if the temperature and humidity are suitable, pit digging type repair method can ensure the pavement performance of long time without damage. On the other hand, scientific evidence shows, the hot asphalt mixture has longer life than the cold material under the dry condition with viscous oil, so filling material in use must ensure that its temperature to meet the requirements.

3.3. Heat drying type repair method

High efficiency heat radiation technology was used in the thermal bake repair method, the old material should be softened before spraying the new emulsified asphalt, then mix the two to spread and build. The main instrument used is infrared heating equipment, on the current situation at home and abroad, LED infrared heating equipment and wall heating equipment is more common[5]. Objectively speaking, compared to other restorations, the most essential characteristic and advantage of the thermal bake repair is the utilization of the old material. Not only do good to environmental protection, reduce cost a lot, it is also easier to implement in the construction conditions. It is worth mentioning that this is not the way to absorb and release heat by the body itself, thus avoiding the risk of the phenomenon of temperature difference due to the thickening of the road surface[6], at the same time it can also avoid the phenomenon of road surface segregation. In this way, the asphalt outlet temperature, transport temperature and paving temperature must under strict control, if the temperature is too high, it will damage the performance of the asphalt, if the temperature is too low, it will reduce its mobility, easy to premature solidification. In the field experiment, we have carried on the strict control to the temperature, and the temperature gun is used to test each stage, begin to fill and pave after determining compliance with relevant specifications. In the compaction process, must be carried out in accordance with the relevant requirements, must not suddenly accelerate or brake, and must not arbitrarily turn around, these practices will affect the final compaction quality to some extent. To make it easier to understand, the specific field temperature is shown below:

Table 1. Compaction temperature

| Pit number | Compaction method | Original press | Second press | End press |
|------------|-------------------|----------------|--------------|-----------|
| 1 | Vibration | 134.1 | 92.2 | 82.2 |
| 2 | Oscillation | 133.9 | 91.6 | 87.6 |
| 3 | Oscillation | 107.5 | 90.2 | 78.6 |
| 4 | Oscillation | 109.2 | 84.2 | 80.2 |
| 5 | Vibration | 95.5 | 82.9 | 65.7 |
| 6 | Oscillation | 92.2 | 83.5 | 75.2 |
| 7 | Vibration | 91.2 | 76.3 | 55.8 |
| 8 | Vibration | 133.2 | 91.8 | 85.6 |

3.4. Jet method

Spray method is a new technology in the field of pavement repair technology, it uses specialized pit tank repair vehicles for road repair. The repair truck comes with a large power blower, cleaning the pothole bottom through continuous ejection of high-pressure air, then spray hot asphalt mixture, in order to achieve the effect of bonding and compaction[7]. Due to the spraying speed is fast enough, so it not only can save the step of mix, but also has improved the repair efficiency.

4. Pit Compaction Technology

Compaction is another key work after the filling. Different compaction methods can affect the performance and working life of asphalt pavement in different degrees, and then affect the road maintenance costs and so on. The wrong compaction will have a negative impact on the technical performance parameters such as porosity, compaction and coefficient about water etc, eventually lead to the occurrence of pavement diseases.

4.1. Vibrating compaction technique

Double steel wheel vibratory roller is generally used in asphalt pavement, most of the highway roadbed, because many places have to use the function and characteristics of road roller, so the double steel wheel vibratory roller has made an important role in recent years[8]. The advantage of vibration compaction is that the depth of vibration in road surface is wide enough, and has a good compaction efficiency. But from another point of view, in the compacted thin road surface, the advantage of vibratory roller is not obvious, the excess energy will make the surface coarse aggregate separated, generate the road lines, and then lead to pavement roughness and density does not conform to the specification[9].

Vibrating compaction make the compaction effect improved on one hand, but at the same time, it also has a great influence on the operator's comfort[10], operation for a long time may also influence the construction efficiency of the operator.

4.2. Oscillatory compaction technique

Oscillation compaction is a new method of compaction after vibration compaction[11]. Different from the vibration compaction, it causes the horizontal direction vibration by the surface layer material particles, to achieve the same separation effect as the vertical vibration, then the particles are arranged irregularly again, not only the energy produced by vibration is effectively utilized, but the disadvantages of vertical vibration are removed, as a result, environment, operators, machinery are all of great benefit, according to this design, the oscillation roller is more and more expanded its frequency and range of use.

We can obtain the concrete compaction effect of the two kinds from the data according to the compaction experiment in the field. More specifically, we prepared two sets of the same number of pit slots, then use the same process to carry on the hole of the pit, and finally use two kinds of equipment to carry out compaction, so as to get two different sets of data, as shown in the following Figure 1:

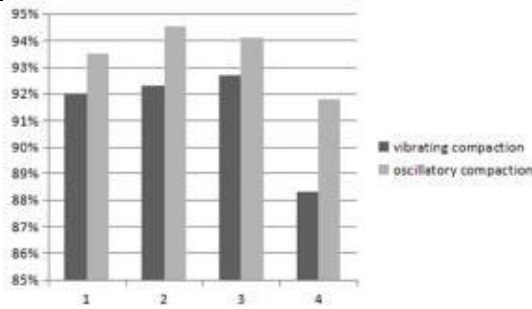


Figure 1. The contrast of compaction degree

5. Technical and Economic Evaluation

5.1. Compaction effect evaluation

In the past twenty years, the theory and practice of comprehensive evaluation technology has made great progress, not only the new method is put forward, but also the old method from time to time has significantly improved or obtained corrected comments.

Evaluation method in recent years has developed to fuzzy comprehensive evaluation method, multivariate statistical evaluation method, hierarchical analysis method and gray system evaluation method from the first comprehensive index evaluation method, efficacy coefficient method, scoring evaluation, composite index evaluation, and later develop to the DEA (Data Envelopment Analysis), ANN (artificial neural network) method. With the development of science, there is a trend of mutual integration and cross development in different fields of knowledge, so is the management science. On one hand, management Science is constantly introducing Systems Science (such as system theory, information theory, etc.), as well as many technical methods (such as computer technology, engineering technology, etc.) research results, to promote the management science to obtain the new achievement with the new vision and the means; on another hand, the synthesis and crossover of different methods can also promote the generation of new methods and new ideas, so is the research on comprehensive evaluation method.

As early as 1888, Edgeworth published a "statistical examination" in the Journal of the Royal Statistical Society, and presented how to weight in different parts of the examination, creating a precedent for the modern scientific evaluation.

Speelman in 1913 had published a article named "relevance of sun and difference", discussed the different weighting function, this article has actually used the multiple regression and the typical analysis.

Factor analysis method [15] is proposed by the British psychologist C.Spearman, is the development of principal component analysis. It uses the thought of dimensionality reduction, through the study of the internal dependencies among numerous variables, and transform the

high correlation of multiple indicators into a small number of independent integrated indicators. Finally realized that reflect most of the information with fewer variables, but also greatly simplifies the index structure of the original index system.

Data envelopment analysis is put forward by well-known research scientists named A.Charnes and W.Copper and other scholars in 1978. It is based on the "relative efficiency" concept, to mathematical planning as the main tool, in order to optimize as the main method, according to multi index input and multi output index for the same type of decision making units (departments or enterprises) of relative effectiveness or benefit evaluation of a system analysis method. DEA method is also widely used in the field, it can be used as a variety of programs of technical progress assessment, effectiveness evaluation and enterprise efficiency evaluation, etc.

Chinese scholar Deng Julong first proposed the grey system theory in 1982. Grey relational analysis (GRA) is to measure the correlation between factors according to the degree of similarity or dissimilarity between the development degree of factors, to reveal the characteristics and the degree of dynamic relevancy. The basic idea is to judge whether the relationship is closely according to the similarity degree of the geometric shape of the sequence. If the curve is closer, the correlation degree between the corresponding sequence is bigger, otherwise the correlation degree is smaller.

Analytic hierarchy process method [12] is proposed by the famous scientist T. L. Saaty operations, it is in accordance with the hierarchical structure of the target, sub goals, constraints and department to evaluate the scheme, with pairwise comparison method to determine the judgment matrix, and to take the maximum eigenvector of the eigenvalues of the matrix corresponding of the component as its weight coefficient, finally calculate the various scheme. As a tool of qualitative and quantitative analysis, this method has been widely used in the field of cost decision, resource allocation and conflict analysis.

System modeling and simulation evaluation method is based on the feedback control theory, by means of simulation. By introducing the concept of dynamic time, the system is simulated by means of computer technology, and then the process analysis and evaluation are carried out. Traditional system simulation methods are Monte Carlo method, discrete time and continuous time simulation method, discrete event simulation and so on. [16-19]. Generally can be achieved through the traditional computer programming language, GPSS language, SLAM language and SIMULINK package in the MATLAB language of these ways to achieve.

Now, more and more areas have adopted the integrated evaluation method, which is about two or more than two kinds of methods to transform and combine to obtain a new evaluation method. At present the problem about the

integrated evaluation is still in the primary stage, so it is called "preliminary integration". Can be divided into the following categories.

General and comprehensive evaluation method combining fuzzy comprehensive evaluation method, that is, the method of fuzzy and grey; integration of general evaluation methods and artificial intelligence methods (intelligent method); evaluation method considering time factor (dynamic method); the integration of evaluation of the evaluation object and evaluation of the evaluation human (evaluation elements integration).

5.2. Evaluation of compaction process

In the compaction process, the production of noise will not only affect the drivers, the surrounding environment is also a kind of damage. Japan understands automobile noise hazards early [13], a "road vehicle law" developed in 1951 define vehicle road noise in the 85D B (A) below; since late 1960s, the United States began to place the local noise control act, and after many years of modification, the driver position noise should not exceed 85dB (A). In both noise impact assessment, the measured low decibel is preferable.

At present, the main evaluation methods of mechanical comfort are: in 1948, Janeway proposed the method to calculate the J value and the Janeway standard curve; K coefficient method ("VD12057") was proposed by Dickman in 1957; in 1968, Pradko proposed the absorption power method, and was characterized by the absorption power ("AP"); 1972 Mitschke proposed a method that the seat vertical direction and vehicle longitudinal acceleration RMS phase can be together; In 1974, there was an evaluation method of ISO2631 internationalization comfort, which was revised and re promulgated every few years; in the last century Liu Jianzhong and SUZUKI (Japan) proposed the SD method [14].

5.3. Evaluation of economic benefit

Even a good road will be damaged, forming a pit. So for a particular road we should conduct the most reasonable repair measures at the most appropriate time point. Timely and reasonable pavement pit repair can increase the opening time of the road, delay the expensive road repair and reconstruction. Maintenance is to improve the bearing capacity and service life of pavement by improving the structural capacity of the pavement. Most maintenance projects can make the pavement life extend 10-20 years, if the repair methods are different, the final repair after the extension of the life time also has a greater difference, and thus the cost of benefits are also different. By selecting the appropriate technical evaluation indicators to verify the effect of pit repair, the end result can be concluded that the oscillation roller in the pit repair quality is superior to vibratory roller. Using oscillation technology in asphalt pavement compaction. Applying ap-

propriate compaction mechanism and mechanical structure to eliminate adverse effects of the vibrating roller in the compacted construction. Effectively improve the compaction problem of asphalt pavement mixture, and at the same time to achieve basic rolling effect on reducing the number of roller compaction, reducing power consumption, greatly saves the unnecessary cost, prompting the asphalt pavement rolling improved effectively on the socio-economic benefits to a certain extent.

6. Conclusion

Now the road is flourishing, with the gradual emergence of pit, gradually lead to a variety of mild to severe environmental, social, economic issues, corresponding repair coping methods also appear. Various methods of pit repair have both advantages and disadvantages, only according to the specific road conditions and mechanical equipment in the preparation of specific and reasonable mix can we produce the best maintenance of the effectiveness of the work.

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